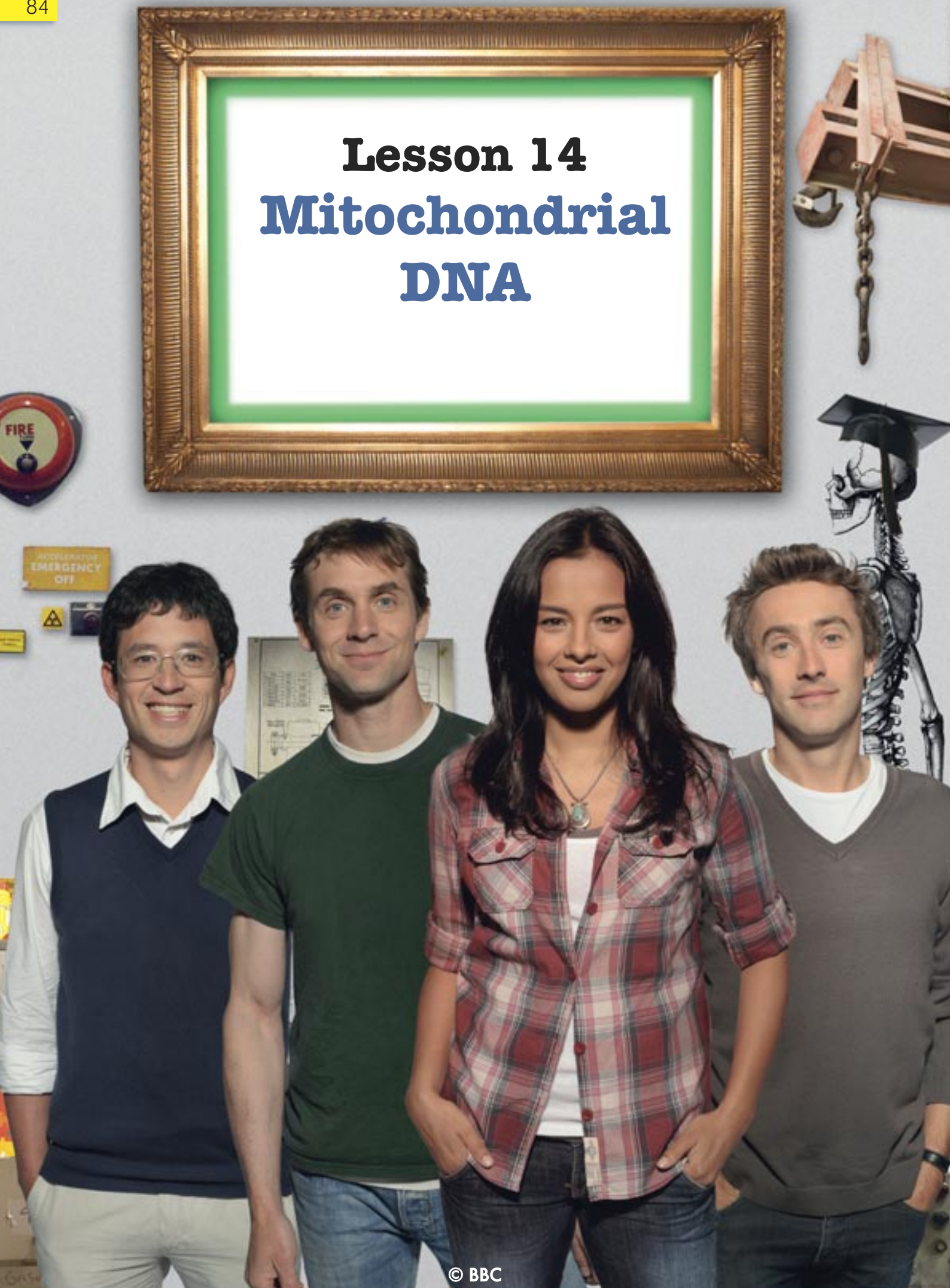
Lesson 14
Mitochondrial DNA



Mitochondrial DNA

Suitable for: 14–16 years
Curriculum and learning links: Evolution, genetics
Learning objectives:

- State the difference between chromosomal and mitochondrial DNA.
- Explain how mitochondrial DNA has been used to trace human ancestry to 'Mitochondrial Eve' and provides evidence for human evolution.

You will need:

- Clips: 14.1, 14.2 and 14.3
- Worksheets: 14A and 14B
- Access to the internet

Opening activity

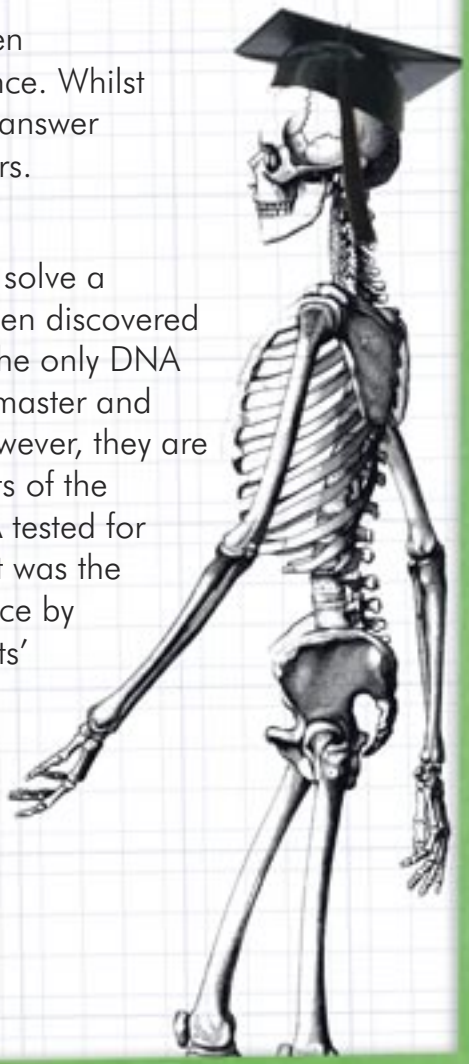
- Review the function (the site of the majority of cellular respiration) and location (within the cytoplasm but not the nucleus) of mitochondria.

Development activities

- Watch **Clip 14.1** in which Liz explains the difference between chromosomal and mitochondrial DNA in terms of inheritance. Whilst watching the clip, ask students to make their own notes or answer questions on **Worksheet 14A**. Review their notes or answers.

Mitochondrial DNA and forensics

- Tell students that they will be acting as forensic scientists to solve a 'missing persons' case. Explain that an old skeleton has been discovered in their school grounds. The bones are so weathered that the only DNA present is mitochondrial. The police think it is an old headmaster and have determined a family tree of the person's relatives. However, they are having difficulty working out which of the living descendants of the headmaster should have their mitochondrial DNA tested for comparison. This analysis would prove whether it was the headmaster or not. Ask students to help the police by completing **Worksheet 14B**. Review the students' results.



Mitochondrial DNA

Mitochondrial DNA and human migration

- Watch **Clip 14.2** in which Liz explains how mitochondrial DNA has been used to track the migration of humans from Africa approximately 200,000 years ago. Explain that mitochondrial DNA is a good source of evidence for human evolution because of its inheritance down the female line, high mutation rates, lack of degradation over time and volume in cells.
- Ask students to research human migration using the internet. Alternatively watch **Clip 14.3** in which Liz explains how her ancestors, as well as those of Dallas and Jem, migrated from Africa.

Reflect and review

- Ask students to answer this potential exam question: Explain how mitochondrial DNA provides evidence for human evolution? [3 marks]
- Answers should include: It is inherited through the maternal line. Mutations can be tracked backwards to make a 'DNA family tree'. This family tree can be used to determine when an organism was alive and see evolutionary relationships between it and others of the same species.

Want to explore further?

- Students could compile a photographic family tree as Liz does in **Clip 14.1**.

Worksheet 14A: Chromosomal and mitochondrial DNA

We will now watch a clip from *Bang Goes the Theory* in which Liz explains the difference between chromosomal and mitochondrial DNA in terms of inheritance. Answer the questions below whilst you are watching the clip.

1. When was the beginning of modern man?

2. What is the name of the 'parcels' of DNA in which our characteristics are inherited?

3. Why is Liz's chromosomal DNA different from that of either of her two parents?

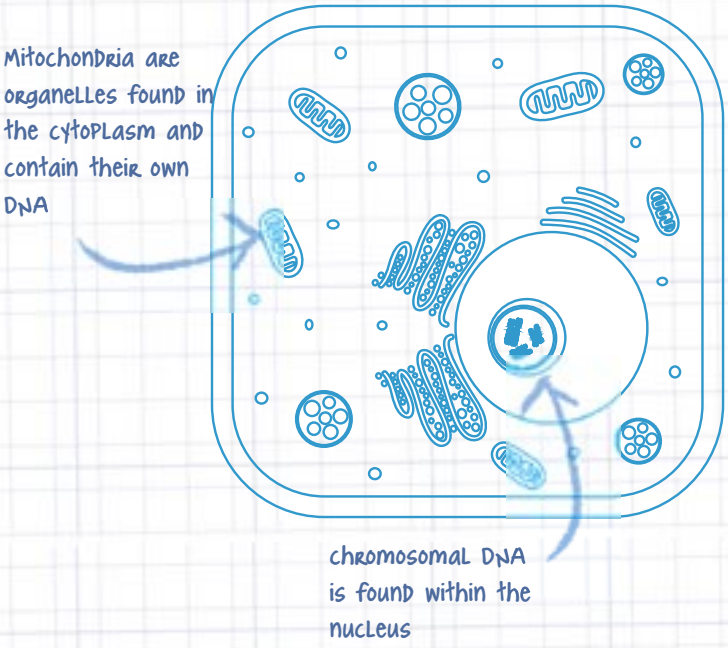
4. What is recombination?

5. Besides chromosomes, where else in our cells is DNA found?

6. What is unusual about this type of DNA?

Worksheet 14B: ‘Missing persons’ case

You will be acting as forensic scientists to solve a ‘missing persons’ case. You will use mitochondrial DNA to do this.

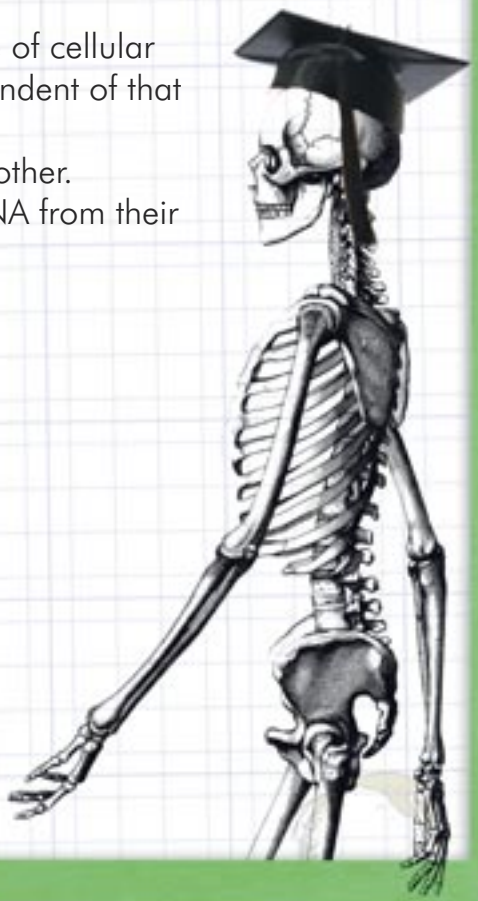


A skeleton has been found in your school grounds. The bones are so weathered that the only DNA present is mitochondrial. The police think it is an old headmaster and have determined a family tree of this person’s relatives. However, they are having difficulty working out which of the living ancestors of the headmaster should have their mitochondrial DNA tested for comparison. Analysis of their mitochondrial DNA would prove whether it was the headmaster or not.

Inheritance of mitochondrial DNA:

Mitochondria are found in the cytoplasm and are the major site of cellular respiration. They contain small sections of DNA that are independent of that found in chromosomes. Importantly:

1. Mitochondrial DNA can only be inherited from a person’s mother.
2. Both male and female children only inherit mitochondrial DNA from their mother.

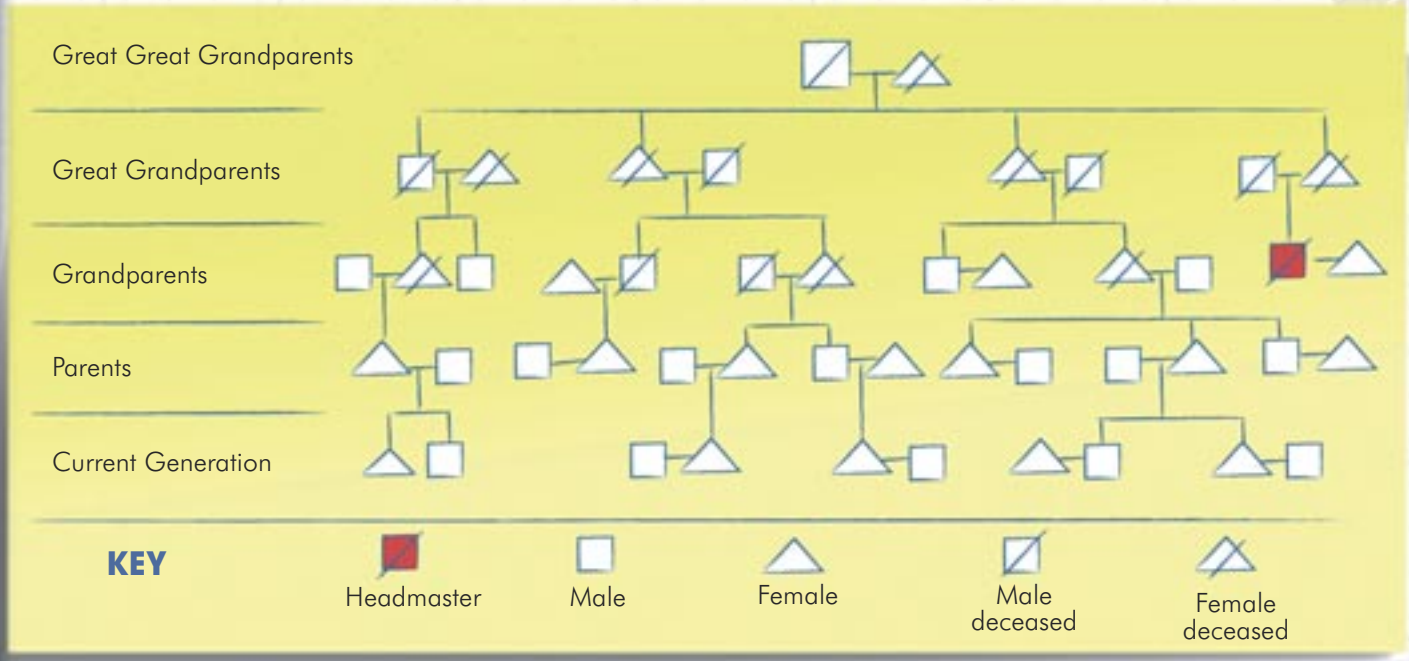


Worksheet 14B: 'Missing persons' case

What to do:

Your task is to identify which of the living individuals in the family tree below should have their mitochondrial DNA tested to determine if the bones belong to the headmaster or not. Unfortunately, all persons that are now dead have been cremated and so they cannot be tested. If you select the correct person or people and their mitochondrial DNA matches, we will know for certain that the bones belong to the missing headmaster.

1. Use a coloured pen to draw over the lines on the family tree connecting any individual that will have inherited the DNA of the dead headmaster.
2. Colour in the individuals connected by your coloured lines to show those that could have their mitochondrial DNA tested.



Questions:

1. What is the total number of individuals who could have their mitochondrial DNA tested?

2. Describe the pattern of inheritance shown in this diagram.

3. How far back could the mitochondrial DNA of the headmaster be traced?